

## A Self-Regulating Freezable Heat Exchanger for Spacecraft, Phase I

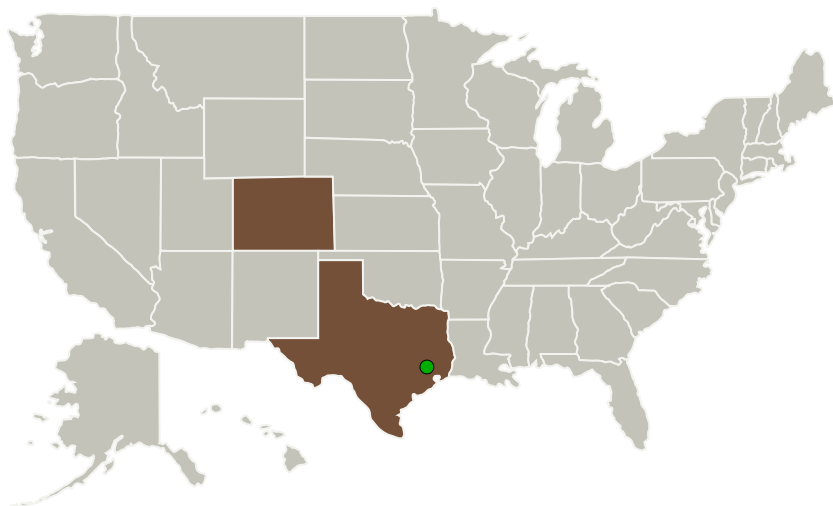
Completed Technology Project (2012 - 2013)



## Project Introduction

A spacecraft thermal control system must keep the cabin (both air and its structure if manned) and electronic equipment within a narrow temperature range even though the environment may vary from very cold to warmer than room temperature. Since water is safe to use and an excellent coolant (other than its high freeze point and volumetric expansion during freeze), a water coolant loop often is used to transport heat to or from the spacecraft via heat exchangers to the heat sink systems that reject heat to space. Some of the heat exchangers would freeze, particularly the ones transporting heat to a flash evaporator or cold radiators exposed to deep space, if not for system controls to prevent it. Yet, the principle of allowing a heat exchanger to freeze can be utilized to increase the turn-down of the heat rejection rate (e.g. to vary the heat rejection from radiators). Unfortunately, the expansion during the phase change of water to ice may damage and ultimately fail the heat exchanger if it is not designed to withstand this event. TDA Research, Inc. has been developing water/ice phase change heat exchangers for several years, since the thermal control system can be simpler (a secondary loop between the coolant water loop and the heat sink systems may no longer be needed) and smaller in size while reducing the use of consumables. Therefore, TDA Research and the University of Colorado propose a lightweight and freeze tolerant water/ice heat exchanger that can passively regulate the heat rejection rate from the water coolant loop to the heat sink systems. The heat exchanger will have no moving parts and thus will be extremely reliable. In Phase I, we will design and build a freeze tolerant water/ice heat exchanger without resorting to a large heavy-walled structure and then subject it to hundreds of freeze/thaw cycles to verify its integrity.

## Primary U.S. Work Locations and Key Partners

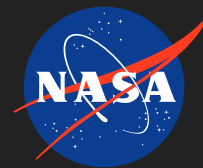


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## Table of Contents

Project Introduction	1
Primary U.S. Work Locations and Key Partners	1
Project Transitions	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	3
Technology Areas	3
Target Destinations	3

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Organizations Performing Work	Role	Type	Location
TDA Research, Inc.	Lead Organization	Industry	Wheat Ridge, Colorado
● Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas
University of Colorado Boulder	Supporting Organization	Academia	Boulder, Colorado

## Primary U.S. Work Locations

Colorado	Texas
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## Project Transitions

▶ **February 2012:** Project Start

✓ **February 2013:** Closed out

## Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/140342>)

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Organization:**

TDA Research, Inc.

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

Carlos Torrez

**Principal Investigator:**

Jim Nabity

**Co-Investigator:**

James Nabity

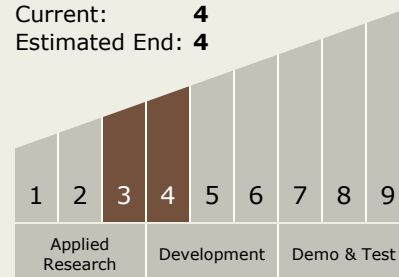
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## Technology Maturity (TRL)

Start: **3**  
Current: **4**  
Estimated End: **4**



## Technology Areas

### Primary:

- TX14 Thermal Management Systems
  - └ TX14.2 Thermal Control Components and Systems
    - └ TX14.2.3 Heat Rejection and Storage

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System